Acerca de este libro

Esta es una copia digital de un libro que, durante generaciones, se ha conservado en las estanterías de una biblioteca, hasta que Google ha decidido escanearlo como parte de un proyecto que pretende que sea posible descubrir en línea libros de todo el mundo.

Ha sobrevivido tantos años como para que los derechos de autor hayan expirado y el libro pase a ser de dominio público. El que un libro sea de dominio público significa que nunca ha estado protegido por derechos de autor, o bien que el período legal de estos derechos ya ha expirado. Es posible que una misma obra sea de dominio público en unos países y, sin embargo, no lo sea en otros. Los libros de dominio público son nuestras puertas hacia el pasado, suponen un patrimonio histórico, cultural y de conocimientos que, a menudo, resulta difícil de descubrir.

Todas las anotaciones, marcas y otras señales en los márgenes que estén presentes en el volumen original aparecerán también en este archivo como testimonio del largo viaje que el libro ha recorrido desde el editor hasta la biblioteca y, finalmente, hasta usted.

Normas de uso

Google se enorgullece de poder colaborar con distintas bibliotecas para digitalizar los materiales de dominio público a fin de hacerlos accesibles a todo el mundo. Los libros de dominio público son patrimonio de todos, nosotros somos sus humildes guardianes. No obstante, se trata de un trabajo caro. Por este motivo, y para poder ofrecer este recurso, hemos tomado medidas para evitar que se produzca un abuso por parte de terceros con fines comerciales, y hemos incluido restricciones técnicas sobre las solicitudes automatizadas.

Asimismo, le pedimos que:

+ *Haga un uso exclusivamente no comercial de estos archivos* Hemos diseñado la Búsqueda de libros de Google para el uso de particulares; como tal, le pedimos que utilice estos archivos con fines personales, y no comerciales.

+ *No envíe solicitudes automatizadas* Por favor, no envíe solicitudes automatizadas de ningún tipo al sistema de Google. Si está llevando a cabo una investigación sobre traducción automática, reconocimiento óptico de caracteres u otros campos para los que resulte útil disfrutar de acceso a una gran cantidad de texto, por favor, envíenos un mensaje. Fomentamos el uso de materiales de dominio público con estos propósitos y seguro que podremos ayudarle.

+ *Conserve la atribución* La filigrana de Google que verá en todos los archivos es fundamental para informar a los usuarios sobre este proyecto y ayudarles a encontrar materiales adicionales en la Búsqueda de libros de Google. Por favor, no la elimine.

+ *Manténgase siempre dentro de la legalidad* Sea cual sea el uso que haga de estos materiales, recuerde que es responsable de asegurarse de que todo lo que hace es legal. No dé por sentado que, por el hecho de que una obra se considere de dominio público para los usuarios de los Estados Unidos, lo será también para los usuarios de otros países. La legislación sobre derechos de autor varía de un país a otro, y no podemos facilitar información sobre si está permitido un uso específico de algún libro. Por favor, no suponga que la aparición de un libro en nuestro programa significa que se puede utilizar de igual manera en todo el mundo. La responsabilidad ante la infracción de los derechos de autor puede ser muy grave.

Acerca de la Búsqueda de libros de Google

El objetivo de Google consiste en organizar información procedente de todo el mundo y hacerla accesible y útil de forma universal. El programa de Búsqueda de libros de Google ayuda a los lectores a descubrir los libros de todo el mundo a la vez que ayuda a autores y editores a llegar a nuevas audiencias. Podrá realizar búsquedas en el texto completo de este libro en la web, en la página `http://books.google.com`

This is a reproduction of a library book that was digitized by Google as part of an ongoing effort to preserve the information in books and make it universally accessible.

Google™ books

https://books.google.com

UNIVERSITY OF CA RIVERSIDE, LIBRARY
3 1210 02473 8641
T_PUB
87/12

REVIEW OF POWER OPERATION AND MAINTENANCE PROGRAM

REVIEW REPORT

Mechanical Features

Great Plains Region

Montana Projects Office

UNIVERSITY OF CALIFORNIA
RIVERSIDE
SEP 29 1992
LIBRARY
GOVERNMENT PUBLICATIONS DEPT.
U. S. DEPOSITORY

Facilities Engineering Branch
Engineering Division
Denver Office
Bureau of Reclamation
UNITED STATES DEPARTMENT OF THE INTERIOR
Denver, Colorado

April 1992

Digitized by Google

Digitized by Google

United States Department of the Interior
BUREAU OF RECLAMATION
DENVER OFFICE
P O BOX 25007
BUILDING 67, DENVER FEDERAL CENTER
DENVER, COLORADO 80225-0007

IN REPLY
REFER TO:

D-5210

Review of Power Operation and Maintenance Program

Review Report

To: Chief, Engineering Division

From: Roger Cline, Mechanical Engineer

Subject: Review of Power Operation and Maintenance - Mechanical Features - Great Plains Region - Montana Projects Office - April 13 through April 16, 1992 (Review of Operation and Maintenance)

GENERAL COMMENTS

1. Messrs. Byron Duke, Chief, Power Division, Jim Lynes, Chief, Canyon Ferry Field Branch, and Sean Keeny, Civil Engineer, all from the Montana Projects Office, and Mr. Adam Mallak, Electrical Engineer, Great Plains Regional Office, participated in the entire review. Mr. Harold Hergenrider, Chief, Yellowtail Field Branch, participated in the review at Yellowtail Powerplant.

2. The facilities visited and reviewed include Canyon Ferry Powerplant, Helena Valley Pumping Plant, and Yellowtail Powerplant.

The following are subjects which were discussed at several locations and are generally applicable to all of the facilities.

3. **Pressure Vessel Inspection and Testing Procedures.** There has been some confusion regarding the testing and inspection of pressure vessels due to conflicting recommendations in the Reclamation Operation and Maintenance Safety Standards (ROMMS), Power O&M Bulletin No. 19, and the Reclamation Construction Safety Standards (CSS). In order to eliminate these inconsistencies and to clarify the inspection requirements, the Denver Office has decided to adopt American National Standard ANSI-NB-23, National Board Inspection Code, as a standard for the inspection of pressure vessels used in operation and maintenance activities administered by the Bureau of Reclamation. Future revisions of ROMMS and CSS as well as Facilities, Instructions, Standards, and Techniques, (FIST) Volume 4-1, which will replace Power O&M Bulletin No. 19, will reference this standard. This standard provides information on inspection procedures, inspection intervals, and the qualifications of the inspector. The National Board Inspection Code is published by The National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Avenue, Columbus, Ohio 43229, telephone 614-888-8320.

Digitized by Google

4. **Synthetic Sling Storage.** Due to the potential of the deterioration of synthetic slings with exposure to ultra-violet light, sling storage and inspection practices were reviewed. Ideally synthetic slings should be stored in a cool, dry, and dark place such as an interior room or enclosed cabinet. Slings were stored properly in all the facilities visited.

5. **Environmentally Safe Grease for Wicket Gate Bushings.** As reported by Dennis Christenson, Superintendent, Hungry Horse Project, at the 1991 Power O&M Workshop, the Husk-ITT Corp. of Signal Hill, California, has developed a environmentally safe grease for use with wicket gate bushings. Once the grease has obtained a H1, "food grade" rating by the U.S. Department of Agriculture, a field test is planned at Hungry Horse Powerplant. In conjunction with the development of this grease, the Research and Laboratory Services Division of the Denver Office is building a working model of a wicket gate for the purpose of comparing the performance of this "environmentally safe" grease, as well as some of the other "food grade" greases available, to industrial grade greases that are known to perform adequately. This model will also be used to evaluate the performance of self-lubricated wicket gate bushing materials.

Also, discussed was the rather aggressive marketing of food grade greases for use in wicket gate bushings being conducted by a number of lubricant distributors. The Bureau of Reclamation, and the hydroelectric industry in general, have little practical experience in the use of food grade greases in wicket gate applications. These greases may perform adequately, but if they don't, the only way to tell is by the premature wear and failure of the bushings which would necessitate the disassembly of the unit to replace the bushings and repair the wicket gate shafts. As this would be a very expensive field test, considerable research should be done before switching greases.

<u>Canyon Ferry Powerplant</u>

6. Project personnel are in the process of making a number of modifications to plant systems in preparation for the remote operation of the plant from the Casper Control Center in Mills, Wyoming. The plant is scheduled to be controlled from the control center by 1996.

7. New strap suspended governor ballheads, shutdown solenoids, microswitch assemblies for the gate limits and speed changers, actuator tank oil level indicator and switch assemblies, and coincidence switch assemblies for gate limit and gate position have been purchased and will be installed in the Fall of 1992 as part of a modernization and maintenance program on the governors. A representative from the Woodward Governor Company will be hired to assist in the installation of the first ballhead and to provide training in maintenance procedures. Plant personnel also plan to go completely through the governors, replacing bearings, pivot pins, and any other parts that may be worn. Following the work on the governors the project will schedule the use of one of this office's permanent magnet generator (PMG) simulators to make final adjustments to the governor.

Digitized by Google

The new actuator tank oil level indicator and switch assemblies are a new design that replace the existing sight glass. The indicator, a GEMS Suresite, replaces the sight glass with a stainless steel float housing that contains a magnet equipped float. Magnetic flags flip over to show a different color as the float rises or falls with the liquid level. Level switches, activated by the float, are mounted external to the float housing.

7. New electronic speed switch systems made by Tetragenics have been purchased to replace the mechanical auxiliary speed switches in the PMG. The mechanical main overspeed switches will remain in service.

8. As part of the modifications for remote operation, new valves with pneumatic operators will be installed on the cooling water supply to the generator coolers. Currently the operators manually change the valve opening based on unit load. A programmable logic controller (PLC) will be used to control the opening of the valves. The PLC will be programmed to open or close the valves to a predetermined setting based on generator load.

The generator coolers are also going to inspected to determine their condition. Material and tools for retubing the coolers will be procured if their condition warrants.

9. Parts for the service air compressors are getting difficult to find. Currently, parts from surplus compressors obtained from Yellowtail Powerplant are being used to keep the compressors operating. The plant service air system is also being used to supply air to the dam's deicing system as the deicing compressor, while operable, is in very bad condition. The deicing compressor has been left in place to use in case the supply from the service air system should become unusable for some reason. Plant personnel plan to replace the existing reciprocating service air compressors with rotary screw compressors with sufficient capacity to provide service and deicing air.

10. All wire rope slings have recently been inspected and any kinked or otherwise damaged slings have been replaced. All synthetic slings have been replaced within the last 6 months. A cabinet was purchased especially for sling storage and all slings are stored properly.

11. Thrust bearing high pressure lubrication systems have been installed on all three units by powerplant personnel. The alignment of all three units was performed following the installation of the systems. Prior to the teardown of the units, the shaft runout was excessive on all three units and had a frequency of one half of the unit frequency. Observing the runout pattern on an oscilloscope indicated a shaft rub in the bearings and preteardown readings confirmed that the guide bearings were not concentric. Once the alignment was complete, the maximum runout diameter was 0.0045 inch, compared to 0.0145 inch before the alignment.

12. The expansion joint on the Unit 3 penstock is leaking significantly. The old packing should be removed, the packing gland cleaned, and new packing installed.

Digitized by Google

Helena Valley Pumping Plant

13. Helena Valley Pumping Plant is operated and maintained by the Helena Valley Irrigation District with assistance from Bureau of Reclamation personnel as required. The plant is unique in that the pumps are driven by hydraulic turbines. During the winter of 1989, Unit 1 was overhauled because the turbine wicket gates would not move. During this overhaul, additional grease grooves were added to the wicket gate journals, a new packing sleeve was installed on the turbine shaft, and new wear rings were installed on the pump impeller. The irrigation district is considering overhauling the other unit this fall and winter. Since the spare impeller wear rings were used on Unit 1, new rings will have to be procured if the wear rings are to be replaced. The standard wear ring materials recommended by this office are nickel aluminum-bronze, UNS C95500 or C95800 against a UNS S30400 or Nitronic 60 stainless steel.

14. Currently the wicket gate bushings and linkage are equipped with individual grease zerks and are greased by hand. Irrigation district personnel are installing surplus grease pumps and metering valves obtained from Yellowtail Powerplant to automate the greasing system and to reduce the time required to lubricate the bushings. This system should help to ensure each bushing consistently receives the correct amount of grease.

Yellowtail Powerplant

15. Unit 4 recently had an unscheduled outage due to high runout at the upper guide bearing. Apparently the unit was being operated in a "rough zone" which caused excessive runout. Due to the excessive runout, the thrust block made contact with a vapor seal causing a rub which increased the runout further and caused the thrust block to heat up. Because of the rub condition and the expanding thrust block, the runout did not decrease when the load was changed from the "rough zone." Maintenance personnel estimated the thrust block temperature to be 200° F upon shutdown and the thrust block had expanded to the point that there was no clearance between the upper guide bearings and the bearing journal. After disassembly, the temperature probe in the guide bearing was found to broken which explained the absence of a high temperature alarm. The guide bearing segments were removed and inspected. There was no significant damage to either the shoes or the bearing journal, so the shoes were lightly scraped, the lubricating oil replaced with clean filtered oil, and the unit reassembled.

The plant is now operated by the Casper Control Center. Project personnel have met with Operations personnel at the Control Center to develop operating procedures that will prevent a similar incident from occurring. The units are equipped with proximity probe systems to monitor shaft runout. The Control Center did receive an alarm on Unit 4, but the load was not changed before the thrust block made contact with the vapor seal. The Control Center now changes load any time the runout exceeds 0.004 inch on any of the bearings. The runout on the upper guide bearing of Unit 4 had exceeded 0.010 inch for several hours before it was finally shut down.

Digitized by Google

16. Cracks in several of the blades of the turbine runner of Unit 3 have progressed past holes drilled to relieve the stress and stop the cracks. The cracks were "stop drilled" during an outage in 1989 and had been dormant up until this year's inspection. Plant personnel report that since the plant has been remotely operated, the units have been operated in the "rough zone" more frequently and for longer periods. Last spring, the units were operated above rated load for approximately 6 weeks. The cracks originally appeared in 1978 after similar operations. The exact reason the cracks have progressed is not certain, but the amount of vibration that occurs during operation in the "rough zone" and above-rated load is a good indication that the runner is being stressed. The vibration caused by draft tube surging has been eliminated at other plants through the injection of compressed air under the runner. Although the operation problems have apparently been resolved (Paragraph 15) it would be desirable to eliminate the vibration problem completely. This office could assist in testing to determine if air injection is feasible for eliminating vibration in the "rough zone."

Personnel from the Electric Power Branch of the Denver Office, have developed a monitor to indicate when a unit is operating in a "rough zone." The device uses a pressure transducer mounted on the draft tube that monitors the draft tube pressure. Typically, the draft tube pressure fluctuates greatly during periods of draft tube surging. The monitor provides a closed contact when this high peak to peak pressure variation is occurring. This monitor could be used in conjunction with an air injection system or simply as an alarm when draft tube surging is occurring.

17. All four units have had new nickel aluminum bronze, UNS C95500 stationary seal rings installed during the time period of 1986 to 1989. According to annual maintenance records, the diametrical clearances have increased an average of 0.010 inch on all four units from 1991 to 1992. The overall clearance varies depending on the length of service. As a general rule, the wear rings should be replaced when their diametrical clearance reaches 200 percent of the design clearance. The clearances of the Yellowtail units should be closely monitored and if the clearances continue to increase at the current rate, funds should be budgeted for procuring replacement rings.

18. It is getting extremely difficult and expensive to obtain parts for the electro-mechanical unit governors manufactured by ASEA. Many of the parts, when available at all, take 10 months to 2 years to obtain. Plant personnel have had to be very innovative in repairing components when they wear out. Currently, there is money budgeted in 1996 for the replacement of the governors. Due to the distinct possibility that a unit could be down for months in the event a critical governor component fails, the replacement of the governors should be given high priority.

The Electric Power Branch and Woodward Governor Company are working on a cooperative research project to develop a digital governor for use with Reclamation Powerplants. A prototype will be installed at Mt. Elbert Pumped-Storage Plant for testing and development during the next fiscal year. Data

Digitized by Google

obtained from this program should be available in 1995 when the specifications for Yellowtail's new governors will be written. This information should be helpful in specifying the pertinent characteristics for the governors if digital governors are procured.

19. The project has purchased a penstock cart for use in the maintenance and inspection of the penstocks. Much of the design work on the cart was done by Dennis Rosberg, GP-218, of the Great Plains Regional Office, although the design and fabrication was contracted out to the Safety Lift Company of Columbus, Ohio. The design has several innovative features for supporting and keeping the cart level that could be used in designs for other penstock and tunnel carts. The project plans to test the cart in the penstock in August or September of 1992, and would welcome anyone who is interested in the cart design to come and observe the tests.

20. All slings are stored in a walk in cabinet. A sign out sheet is located in the cabinet to document the condition of each sling when it is removed and again when it is returned. By requiring the signature on the inspection sheet, the user of the sling is reminded to perform a thorough inspection and damaged slings are more likely to be taken out of service.

21. New wicket gate greasing systems have been procured for all four units. The systems have been installed and are operational on three of the units. The final system was being installed at the time of the review. The systems include new grease pumps, routing valves, metering valves, and programmable logic controllers to control greasing frequency. Most of the old piping was reused. The old pumps and metering valves were sent to the Helena Valley Pumping Plant to be installed on the pumping units there (Paragraph 14).

RECOMMENDATIONS

Canyon Ferry Powerplant

R1. Schedule the use of the Denver Office's PMG simulator to test and adjust unit governors after the modifications discussed in Paragraph 7.

R2. Budget funds for the replacement of the station service air compressors.

R3. Replace the packing in the Unit 3 penstock expansion joint.

Yellowtail Powerplant

R4. Schedule tests to determine the effectiveness of air injection to reduce the vibration that occurs in the "rough zone."

R5. Closely monitor the progression of the cracks on the Unit 3 turbine runner. If there is further progression, contact this office so that a repair procedure can be prepared.

Digitized by Google

R6. Monitor the wear ring clearances on all units paying close attention to the rate at which the clearance is increasing. Budget funds for replacement rings if the clearances are approaching 200 percent of design clearance.

R7. Make the replacement of the governors a high priority budget item. Contact this office if assistance is required in writing the specifications for the new governors.

Roger Cline, Mechanical Engineer

Concurred: James D. Sloan, Chief,
Facilities Engineering Branch

Approved: David W. Harris, Chief
Engineering Division

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google